Sains Malaysiana 42(8)(2013): 1027–1040

Platforms of Climate Change: An Evolutionary Perspective and Lessons for Malaysia

(Platform Perubahan Iklim: Perspektif Bersifat Evolusi dan Pengajaran untuk Malaysia)

KOH FUI PIN, JOY JACQUELINE PEREIRA* & SARAH AZIZ

ABSTRACT

The discourse on climate change of both natural and anthropogenic origins has a long history and the subject has been discussed from both scientific and social perspectives. This paper reports on a study that begins with a review of the historical perspective of the subject with a focus on the enhanced greenhouse effect from the 15th to 19th centuries by identifying the main discussion platforms and delineating their temporal and substantial interactions. The three main climate change platforms are the science platform, the media platform and the policy platform. The science platform is where theories related to the greenhouse effects and their enhancements are developed. The media platform comprises newspaper coverage on climate change themes, while the policy platform is mainly the UN and its decisions relating to climate change. The authors assert that if not for the discussion, attention and actions within each, the climate change discussion would not have become so intense and the climate change agenda would not have been furthered. It is observed that less attention is given to science-media interaction compared to science-policy interaction. Similarly, NGOs have received little attention in these platforms and their interactions. The second part of the paper presents a descriptive case study that was undertaken to discuss the climate change agenda at a national level to determine whether the national scenario will have a pathway similar to that of the global one. It is suggested that in Malaysia this agenda is more likely to be driven by policy. The country's climate change policy is expected to address the needs and gaps identified in this study.

Keywords: Climate change; climate policy; climate science; environmental policy; Malaysia; media coverage

ABSTRAK

Wacana mengenai perubahan iklim kedua-dua asal-usul semula jadi dan antropogen mempunyai sejarah yang lama dan perkara ini telah dibincangkan daripada kedua-dua perspektif saintifik dan sosial. Kertas ini melaporkan satu kajian yang dimulakan dengan menilai semula platform-platform perbincangan utama perubahan iklim di peringkat antarabangsa dengan memberikan tumpuan kepada kesan rumah hijau yang semakin meningkat dari abad ke-15 sehingga ke-19 dan menggambarkan interaksi platform-platform tersebut secara temporal dan kepentingan. Tiga platform utama perubahan iklim adalah platform sains, platform media dan platform dasar. Platform sains ialah tempat teori-teori berkaitan dengan kesan rumah hijau dan peningkatan mereka dibangunkan. Platform media terdiri daripada liputan akhbar pada tema perubahan iklim, sementara platform dasar ialah PBB dan keputusannya yang berkaitan dengan perubahan iklim. Para penulis menegaskan bahawa jika tidak untuk perbincangan, perhatian dan tindakan dalam setiap platform, perbincangan perubahan iklim tidak akan menjadi begitu mendalam dan agenda perubahan iklim tidak akan dilanjutkan. Adalah diperhatikan bahawa kurang perhatian diberikan kepada interaksi sains-media berbanding dengan interaksi sains-dasar. Walau bagaimanapun, NGO telah menerima sedikit perhatian dalam ketiga-tiga platform tersebut dan interaksi mereka. Bahagian kedua kertas ini membentangkan satu kajian kes deskriptif yang telah dijalankan untuk membincangkan agenda perubahan iklim di peringkat kebangsaan untuk menentukan sama ada senario kebangsaan akan mempunyai satu trend yang serupa dengan yang global. Di Malaysia, agenda tersebut berkemungkinan didorong oleh dasar. Dasar perubahan iklim negara dijangka menangani keperluan dan jurang yang dikenal pasti dalam kajian ini.

Kata kunci: Dasar alam sekitar; dasar perubahan iklim; liputan media; Malaysia; perubahan iklim; sains perubahan iklim

INTRODUCTION

The incoming energy from the Sun and the properties of the Earth and its atmosphere are the main factors that determine the global mean climate of the Earth. Alteration of the global energy budget of the Earth resulting from the changes in several aspects of the atmosphere and the Earth's surface can cause the climate to change (Solomon et al. 2007). Among the changes that have been taking place in the atmosphere and on the Earth's surface, the one of most concern to humankind is the increase of greenhouse gas concentration.

Over the years, climate change has become a major topic of discussion. New observations and projections have been provided. New natural events have been experienced by the public in different parts of the world. Thus, whenever climate change is discussed, the attribution to its primary

cause is the most debated item on the agenda. The greenhouse effect is one of the most frequently mentioned phenomena. However, this development of discourse on climate change would not have taken place without prior efforts.

A huge amount of literature on climate change is available as it has been a developing topic of focus which began growing in the 1800s (Handel & Risbey 1992; Stanhill 2001). They provide an area of study on the historical perspective of climate change, particularly on the evolution of awareness on the enhanced greenhouse effect from scientific research to a global response. Researchers such as Corfee-Marlot et al. (2007), Fleming (1998), Kellogg (1987) and Weart (2004) present evidence of the evolution of awareness on climate change. Though they share similarities in scientific discoveries, public concerns and policy responses, these authors' research differ in their level of discussion focusing on these three aspects.

This study reviews the evolution of the climate change discourse by identifying its main platforms where ideas and opinions were most expressed and recorded. A review of theory developments, newspaper coverage and decision adoption is presented, illustrating how the subject was perceived and addressed on different platforms. It commences with a description of the three main platforms of climate change, i.e. science, media and policy. On the scientific platform, the development of theories related to the greenhouse effect and its enhancement is observed. On the media platform, the graphs of newspaper coverage on climate change themes are drawn. On the policy platform, the decisions of the United Nations relating to climate change are noted. In this section, the temporal and substantial interactions are differentiated and discussed. The review is followed by a descriptive case study. The purpose is to discuss whether the climate change agenda at a national level will follow that which has been set by the global pathway. The conclusions are highlighted in the final section.

Materials and Methods

Review Approach

Literature was reviewed to obtain a historical perspective of climate change from scientific research, coverage by the media and the establishment of the United Nations Framework Convention on Climate Change (UNFCCC). The material reviewed encompassed peer-reviewed journals, books and reports of international agencies. The review helps to identify the platforms of climate change and examine their interactions.

Quantitative Analysis

A quantitative analysis was performed to investigate the trend of climate change according to the newspaper reports prior to and after 1988 till 1992. The rationale behind beginning with the specific year of 1988 was, that it was generally known as the peak of media coverage of climate change (Boykoff & Roberts 2007; Corfee-Morlot et al. 2007; Ungar 1992; Wilson 2000) and it has become a point of departure for studies on media and climate change. In fact, anthropogenic climate change received its media coverage in the late 1950s but remained sparse for the next three decades (Boykoff & Roberts 2007) which could due to scientific work done did not seem to impressed the general public whose awareness of climate issues seemed to influenced by the rise and fall of the temperature trends (Fleming 1998). This approach was applied to expand the scenario to include media coverage on climate change prior to 1988. 'Climate change', 'greenhouse effect' and 'global warming' were three keywords used to track their appearance in the headlines by using the Lexis Nexis Academic database. It is a similar method used by others focusing on media coverage of climate change (Boykoff 2008; Boykoff & Roberts 2007). The 'greenhouse effect' was an additional term in the search because it had been the focus on the scientific platform. Besides, reviews show that the term 'greenhouse effect' used by Humphrey (1929) is its earliest user (Handel & Risbey 1992).

Results and Discussion

Platforms of Discourse

In this study, science, media and policy are the three identified main platforms of climate change. Each platform has a focus on its role with respect to climate change. The focus on the science platform is placed on the development of greenhouse effect theories, while the focus on the media platform is on the newspaper coverage of climate change themes and the focus on the policy platform is on the climate change related decisions of the United Nations (UN).

The Science Platform

The greenhouse effect is a natural mechanism referring to the absorption and emission of infrared radiation towards the earth by trace gases in the atmosphere, trapping heat within the surface's troposphere system (Le Treut et al. 2007). However, the increased concentration of these trace gases, which are also known as greenhouse gases, primarily due to unsustainable development by humans, enhances the mechanism (Le Treut et al. 2007).

This phenomenon was first investigated by the science community more than four centuries ago. An overview of these efforts is presented in Table 1. Between the 1600s and 1700s, research was conducted in order to understand the energy system of the Earth. By the turn of this century, an experiment was conducted demonstrating the heating effects of the sun's rays (Fleming 1998; Fourier 1824; Le Treut et al. 2007) and this was noted for providing an early analogy to the greenhouse effect (Le Treut et al. 2007). This idea was further studied and expanded to suggest theories of terrestrial temperature

in the early 1800s (Fleming 1998). In approaching the mid-1800s, research was conducted to identify the 'agent(s)' responsible for heat radiation and absorption. Water vapour and carbon dioxide were two important 'agents' identified (Tyndall 1861). They played a role in the subsequently proposed climate theories. By the end of the 1800s, it was observed that theories suggesting the rise of temperature with added carbon dioxide in the atmosphere both anthropogenically (Arrhenius) and naturally (Chamberlin) were put forward and had asserted substantial influence on subsequent climate discourses (Hart &Victor 1993).

Research and efforts on the science platform can be observed in several shorter periods beginning in the early 1900s. With the early 1900s came the beginning of industrial processes and other activities which naturally led to discussions on human interference with the Earth's temperature. A non-technical book was published which noted that the rapid increase of carbon dioxide from industrial processes might raise the earth's surface temperatures in a few centuries (Arrhenius 1908). A few decades later, the term 'greenhouse effect' was used and Humphrey (1929) was its earliest user (Handel & Risbey 1992). During the mid-1900s, discussions on the effects of increased anthropogenic carbon dioxide on rising temperatures gained attention and relevant research was conducted. The anthropogenic carbon dioxide-centred discussion to determine its amounts in the atmosphere continued. By the late 1950s, the initial understanding of the absorption capacity of the ocean as a carbon reservoir was presented (Revelle & Suess 1957). Subsequently, an atmospheric monitoring programme was conducted at the Mauna Loa Observatory Station and an environmental icon known as the 'Keeling Curve' was produced which reflected a steady growth of atmospheric carbon dioxide since 1957 (Fleming 1998; Hart & Victor 1993; Weart 2004). Soon after, an atmospheric modelling community emerged with the help of computer innovation (Weart 2004) and evolved into the second major discourse of the climate change argument which investigated the consequences of increased carbon dioxide on the climate based on numerical atmospheric modelling (Hart & Victor 1993).

While previous studies showed a trend of increasing concentration of atmospheric carbon dioxide and its impacts on the rising temperature, the mean temperature of the Northern Hemisphere began a cooling trend in 1950 (Kalnicky 1974). Details of the causes of the cooling were not in the discussion of the history of the study of the greenhouse effect and climate change. Nonetheless, an explanation for this scenario was the emission of aerosols or particulates from industries and agriculture (Agrawala 1998a; Fleming 1998; Kellogg 1987). By the 1980s the warming discourse dominated discussions (Agrawala 1998a; Kellogg 1987) and remains ongoing.

The development of theories however is a noticeable achievement on the science platform. It is also observed that, beginning in the mid-1900s, scientific perception of climate change was shifting from it previously being viewed as something beneficial to something threatening. Up until the early 1900s, it was believed that rising temperatures were beneficial to mankind and cultivation (Arrhenius 1908; Callendar 1938). Moreover, it was believed this would delay the return of glaciers indefinitely (Callender 1938). However, it became a matter of national security in the late-1950s with the emergence of nuclear weapons and their fallouts believing they could change the climate or weather affecting the human health and environmental quality as well as threatening the civilization (Fleming 1998; Hart & Victor 1993; Weart 2004). Subsequently, it was a matter of pollution and weather modification in the late-1960s and what began growing as an environmental problem in the 1970s became heightened by the rise of environmentalism (Hart & Victor 1993; Weart 2004). In the early 1970s, two studies, namely the Study of Critical Environmental Problems (SCEP) and the Study of Man's Impact on Climate (SMIC) highlighted the perception of human-climate interaction.

In addition, the climate change research which until then was sporadic and left no programmatic legacy was institutionalised and sustained with support beginning in the mid-1900s (Andresen & Agrawala 2002; Hart & Victor 1993). Prior to the 1900s, seminal works from scientific platforms were mainly driven by the intellectual enthusiastic views of a few scientists (Lanchbery & Victor 1995). Beginning in the mid-1900s, the institutionalisation of climate change research was observed. It gained attention in the 1970s due to the efforts of the World Meteorological Organisation. By the end of the 1970s, the WMO held the first World Climate Conference and established the World Climate Programme to initiate and coordinate activities with respect to climate data collection, climate research, applications and training and to mobilise required national and international resources (WMO 1979). These attempts were followed by the establishment of the Advisory Group on Greenhouse Gases (AGGG) in 1986 and the Intergovernmental Panel on Climate Change (IPCC) in 1988.

THE MEDIA PLATFORM

The studies on climate change which were undertaken by the science community during the 1700s and early 1800s were concurrent with the development of modern media in its initial stages. However, the earliest entry point of climate change coverage noticed was in the early 1900s (Boykoff & Roberts 2007). The initial development stages of the modern media were constrained by challenges and conflicts such as state-control over the public sphere, low literacy competency and technological capacity challenges (Starr 2004). This would be the main cause of the insignificant media coverage of climate change. The cross-development of these two platforms prior to the 1900s did not help the issue to gain attention, which only happened at the turn of the 20th century.

TABLE 1. Overview of research and efforts leading to the scientific understanding of climate change and greenhouse effect

Period	Scientific research and efforts leading to the understanding of climate change and greenhouse effect
1700s	To understand the energy balance of the climate system
1600s	To demonstrate heating effect of Earth's surface
	Industrial Revolution
1800s	To suggest terrestrial temperature To determine the absorption and radiation ability of heat by gases and vapours To suggest climate theories To discuss the atmospheric carbon dioxide and surface temperature To study the geochemical carbon cycle and climate
	World War I
Early 1900s	The term 'greenhouse effect' was applied To discuss changes in climate due to industrial process and other humans' activities To demonstrate the relationship between anthropogenic carbon dioxide and surface temperature
	World War II
Mid 1900s	World Meteorological Organisation was established To study absorption capacity of ocean as carbon reservoir International Geophysical Year (IGY) To conduct atmospheric monitoring programme To conduct atmospheric modelling study To study greenhouse gases other than carbon dioxide
1970s	Published of the Study of Critical Environmental Problems (SCEP) Published of the Study of Man's Impact on Climate First World Climate Conference World Climate Programme launched to coordinate international research on climate
1980s	Villach Workshop to suggest amongst the recommendation a global convention Advisory Group on Greenhouse Gases (AGGG) was formed Intergovernmental Panel on Climate Change (IPCC) was established Scientific testimony of high level confidence on human-induced warming by NASA chief scientists World Conference on the Changing Atmosphere: Implications for Global Security (Toronto Conference) urged for specific greenhouse gas emissions reduction
1990s	Published of IPCC First Assessment Report Published of IPCC Supplementary Report

Studies were conducted on the media and climate change beginning in the late-1900s. Media plays a role in portraying key events of climate change. Its news reporting also influences risk perception and public understanding on climate change (Corfee-Morlot et al. 2007). A study showed that between 1986 and 1995, the scientific uncertainty about climate change was a very common and salient theme found in popular presses such as The New York Times, The Wall Street Journal, The Chicago Tribune and the Los Angeles Times (Zehr 2000). This 'uncertainty' had been transformed through controversy or disagreement among scientists, giving rise to new research topics and methodology, research values and journalism salient to the topic (Zehr 2000). Research had been conducted which showed a tendency of misconception by lay people between what stratospheric ozone depletion and the greenhouse effect was, as well as the difference between weather and climate in the early 1990s (Bostrom et al. 1994).

In this study, the media platform focuses on the trend of newspaper coverage on climate change themes. The trend of newspaper coverage on 'climate change' and 'global warming' was studied by Boykoff in 2008 and Boykoff and Roberts in 2007. These two themes are included in this study with an additional theme - the greenhouse effect. A search for these three themes was conducted to track their appearance in headlines and lead paragraphs of articles of major world newspapers over a period of time. It resulted in two figures consisting of trends of newspaper coverage on these selected climate change themes from 1969 to 1987 (Figure 1) and from 1988 to 1992 (Figure 2).

Newspaper coverage of the subject was insignificant until the late-1970s. An extraordinarily sharp increase in the newspaper coverage of these three themes was from 1987 to 1988. This was the first peak of newspaper coverage on the subject in the 1900s. 'Climate change' was a popular theme compared to the other two. The newspaper coverage of climate change capturing the theme 'climate change' and 'global warming' was fairly equal in the 1980s. However, when this trend was introduced with 'greenhouse effect', the theme overtook others and stood

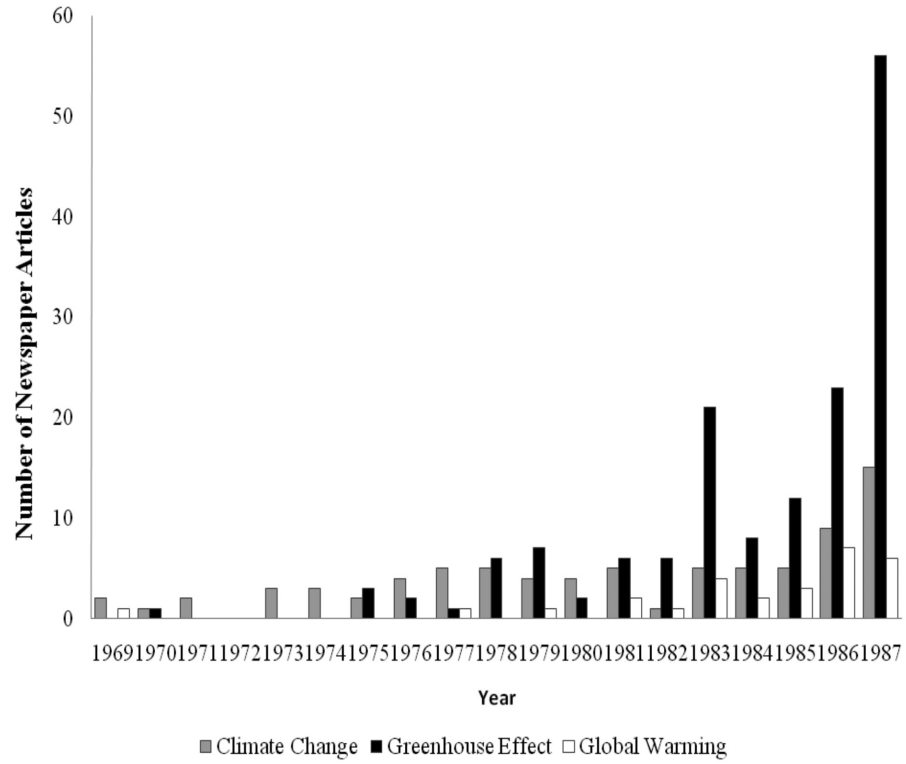


FIGURE 1. Newspaper coverage of climate change, greenhouse effect and global warming prior to 1988

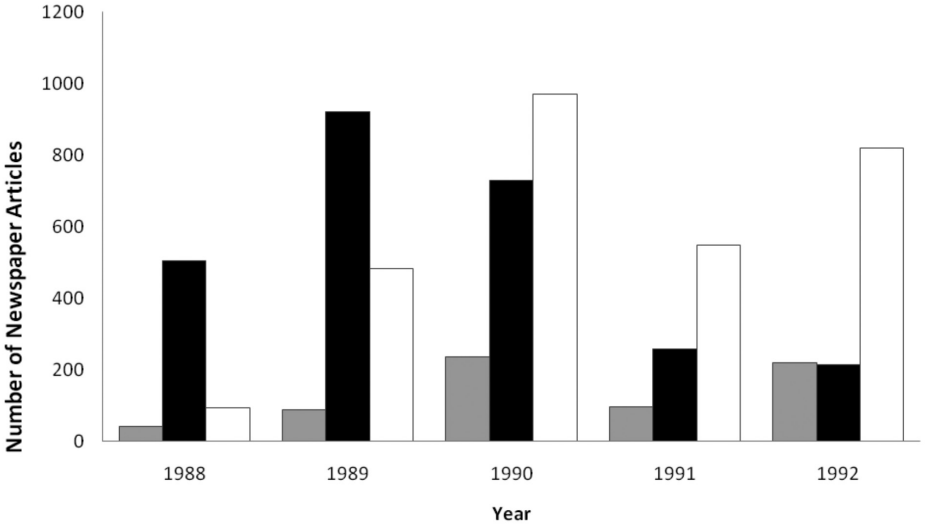


FIGURE 2. Newspaper coverage of climate change, greenhouse effect and global warming from 1988 to 1992

out from 1983 until 1989 (Figures 1 and 2). By the 1990s, the attention shifted to 'global warming' and its coverage overtook that of the 'greenhouse effect', while newspaper coverage on 'climate change' was the lowest among these three themes. It is observed that the popularity of the climate change themes by newspaper coverage evolved from 'climate change' in the 1970s, to 'greenhouse effect' in the 1980s and to 'global warming' in the early 1990s. There was also a tendency of applying fewer technical climate change terms in headlines and lead paragraphs of newspaper articles.

THE POLICY PLATFORM

The first environmental mega-conference was the United Nations Conference on Human Environment (UNCHE) held

in 1972 (Seyfang 2003). It led to the founding of the United Nations Environment Programme (UNEP). Following this was a series of United Nations (UN)-sponsored climate-related conferences on food, water and desertification (Table 2). These UN conferences on the environment resulted in declarations and action plans for subsequent activities.

It was about a decade after the first environmental mega-conference that climate change reached the UN agenda. The issues of climate change began to receive international attention in the 1980s (Corfee-Morlot et al. 2007). There were international scientific conferences and institutional set-up that brought together the scientists and policymakers to discuss and to cooperate on climate change (Table 1) together with a growing trend of media coverage for the issue (Figure 1) in the 1980s. The UN addressed the anthropogenic climate change in its 43rd Session of the General Assembly (GA) in 1988. A resolution was adopted that recognised the 'climate change is a common concern of mankind, since climate is an essential condition which sustains life on earth' (UN 1988). It affirmed the human causes to climate change and its consequences on mankind, both economic and social and implications for present and future generations (UN 1988). Furthermore, it acknowledged the urgency of the issue and urged for a global framework for actions (UN 1988). In the following year, the United Nations General Assembly (UNGA) at its 44th session supported the preparation for negotiations on a framework convention on climate change (UN 1989). By 1990, an Intergovernmental Negotiating Committee (INC) was established for negotiation purposes (UN 1990). The first INC was held in February 1991 and met another four times between then and May 1992 (Agrawala 1998(b)). The outcome of a series of intensive negotiation sessions was the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) on 9 May 1992.

The negotiation for an agreement on a global climate convention showed a different dimension of the climate change debate. The conflict with regard to this subject became more obvious when there were also growing economic and domestic interests in addition to the predominance of scientific and environmental concerns about anthropogenic climate change (Andresen & Agrawala 2002; Bodansky 1993). This situation was particularly so for the 'North', where countries had a longer participatory history on the subject. There were two main coalitions, namely the 'precautionary' coalition represented by environmental groups, ministry officials and the scientific community which was in favour of strong national commitments to address climate change and the 'economic growth' coalitions represented by business groups and economic and trade ministry officials, which were resistant to taking actions in addressing climate change that cannot be justified on economic grounds (Sewell 1996). The 'South', however, was confronted with more immediate national concerns such as poverty, drought and war. In addition, there were differences not only within the groups of 'North' and 'South' but also between these two groups, as well as the emergence of different coalitions in the politics of climate change (Paterson & Grubb 1992).

TEMPORAL RELATIONS

The review of the three main platforms of climate change in the period from the 1600s until the early 1990s shows that there were scientific discoveries, newspaper reporting and policy responses.

Science is the earliest discussion platform. The early scientific discoveries with regard to climate change and greenhouse gases were an important driver. They answered questions on the Earth's temperature and revealed the relationship between the changes in temperature and concentration of carbon dioxide. It is the science platform that has alerted us to human induced warming as a consequence of industrial development. Pieces of scattered individual seminal works developed into the institutionalisation of the climate change agenda, consolidating the diversity of research and discussion which then attracted a wider audience to react to the issue.

TABLE 2. Overview of efforts leading to the scientific understanding of climate change and greenhouse effect

Period	Occasions leading to an establishment of a climate change convention
1970s	United Nations Conference on Human Environment (UNCHE) United Nations Environment Programme (UNEP) was established United Nations World Food Conference United Nations Water Conference
1980s	United Nations General Assembly (UNGA) 43th session acknowledged the urgency of the climate change and urged for a global framework for actions UNGA 45th session supported UNEP and WMO to prepare for negotiations on a framework convention on climate change
1990s	UNGA 44th session decided on establishing the Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change United Nations Conference on Environment and Development Framework Convention on Climate Change opened for signature

The media is the second discussion platform. By publishing the science of climate change, it disseminates information to the public in the most direct way. Thus its influence on its readers' understanding and attitudes towards the issue of climate change should not be underestimated. It is observed that over the years there has been a growing interest in the media on climate change reporting.

Policies are the third discussion platform. They bring together global actions to address the challenges of climate change under the auspices of the UN. The discussion is a complex one. It is also observed that climate change is not restricted to being treated as an environmental issue; rather it has been expanded to ride on social and economic matters as well.

The 1600s to mid-1900s was an important period for early scientific studies on climate change and the greenhouse effect in reaching an understanding of the subject. The earth sciences disciplines played a major role overshadowing that which was played by other disciplines. Newspaper coverage which began in the late 1960s and the introduction of the UN to the climate change picture in the 1970s did not have a significant effect on the subject. The 1980s was the turning point for the subject: it saw a stronger coalition of these three main platforms and the greatest attention focused on the subject thus far for that particular period. The 1990s marked the start of global action addressing the issue when the negotiation for a framework convention on climate change was initiated by the UN. Clearly, the capacity for knowledge generation and communication within the scientific community has attained a higher level.

INTERACTION BETWEEN THE PLATFORMS

In the long historical period of climate change discussion, there were several important efforts leading to the understanding of climate change and the greenhouse effect, to the publication of knowledge and information and to the establishment of a framework convention. From a purely scientific exercise to various interactions among different platforms, efforts at addressing climate change succeeded in getting a convention established in 1992. The interactions among the platforms and their periodic developments are mapped out in Figure 3.

The science platform has been the leading platform. Its first interaction was with the media platform. In the early stages of climate change reporting, when defining the problems and analysing the causes were part of the story framing process, scientists were the primary sources (Wilson 2000). Its second interaction was with the policy platform which was observed in the 1970s at the United Nations Conference on Human Environment. The Study of Critical Environmental Problems (SCEP) and the Study of Man's Impact on Climate (SMIC) produced reports which became background papers to the conference (Kellogg 1987). Later, towards the 1980s, the World Climate Programme was established and it generated substantial scientific knowledge for the IPCC and UNFCCC (Seki & Christ 1995). The science-policy interaction became more obvious in the late 1980s. For instance, the Villach 1985 Workshop moved the climate change discussion forward from its science constraints into global policy action (Agrawala 1998(a)). It delivered three notable remarks with regard to policy in terms of collaboration between scientists and policy-makers, consideration of a global convention and a discussion on the establishment of an international co-ordinating committee on greenhouse gases (WMO 1985). The Advisory Group on Greenhouse Gases (AGGG) 1986 was established to conduct scientific research activities and advice on policy matters with regard to climate problems and a global climate convention (Agrawala 1999). The establishment of the IPCC was done with a more significant science-policy interaction intention and role (Figure 4) (Agrawala 1998(b), Siebenhüner 2003).

It is observed that the interaction between science and policy platforms and its implications on the climate change discussions have received more attention compared to the interaction between science and media platforms. Although science-media interaction on climate change has an earlier timeline, it is observed that this relationship was not sustained and hence the implications of this interaction are not well understood. There is a need to address this situation when sources of information and modes of communication have increased. The interaction should be strengthened to improve mutual understanding, skills and knowledge. New opportunities through mass communication media should be explored to attract more attention to the climate discourse, especially among the younger generation.

Towards the mid-1980s, the coalition of these three platforms was taking form (Boykoff & Roberts 2007). Its impact on the climate change discussion was greater than the interactions between science-media and science-policy. It had led to the shaping of media reporting and public understanding by the sciences, policy and ecological-meteorological events, while journalism and public concern had helped to shape the science and policy platforms' decisions and activities (Boykoff 2008). Subsequent to this coalition, there had been substantial growth of attention on the subject in the following years (Figure 3).

While interactions have been identified within the science, media and policy platforms, it is observed that the roles of non-governmental organisations (NGOs) received little attention in the history of the study of climate change. The extent of NGO participation and its influence in the climate debate is unknown, particularly in the pre-UNFCCC period. The roles and participation of NGOs are prominent in the post-UNFCCC period.

A study had been conducted to examine changes in attitude and awareness among NGOs and their implications for the climate change negotiating process and debate, which started at the third session of the Conference of the Parties in 1997 (Carpenter 2001). The NGOs included

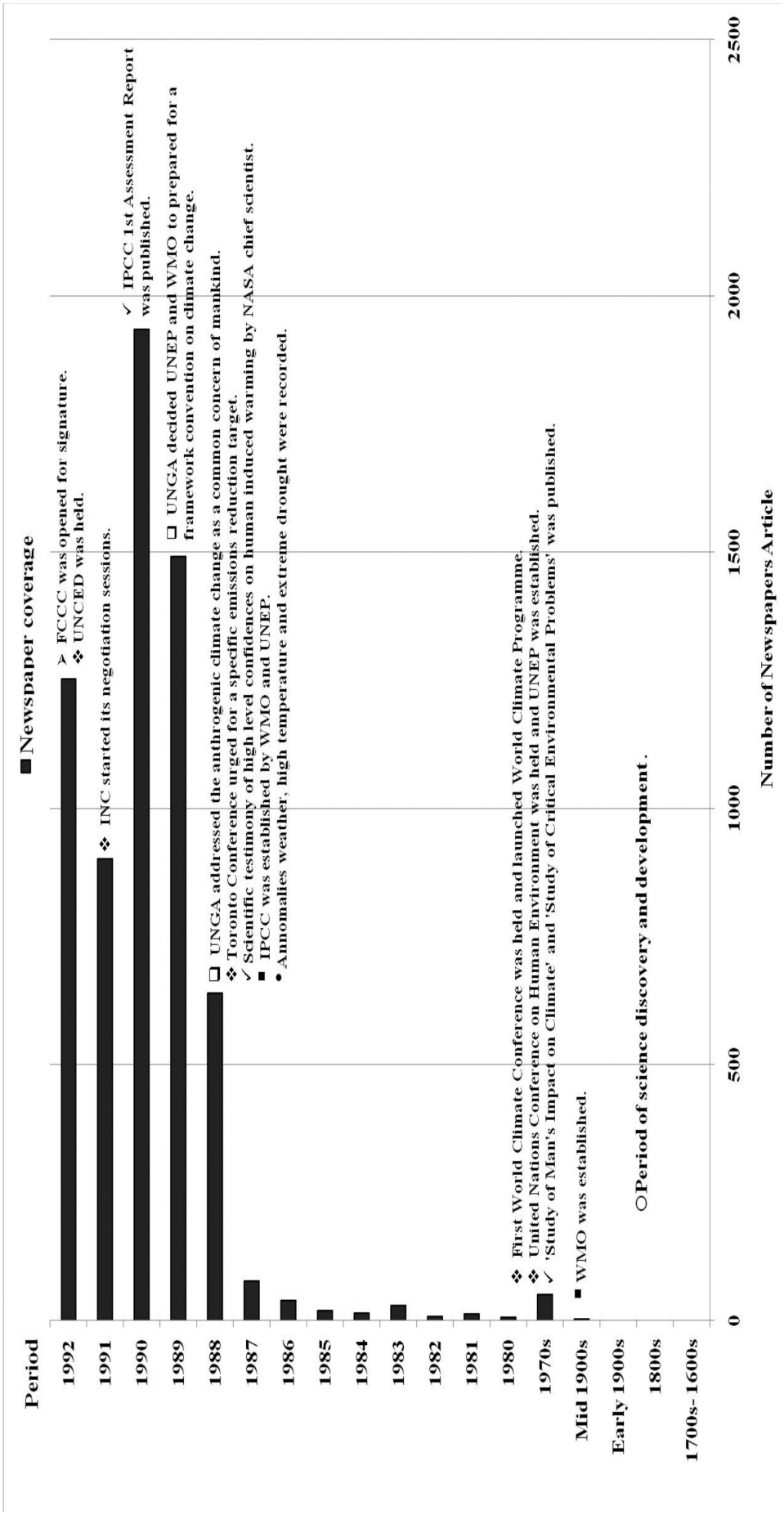
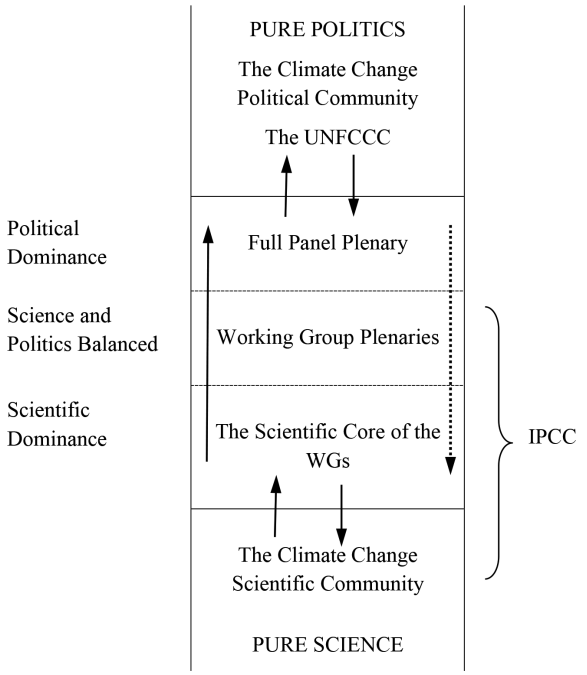


FIGURE 3. Overview of interactions among the science, media and policy



Source: Alfsen and Tora (1998). The IPCC provides an significant science-policy interaction platform

FIGURE 4. The different levels of the IPCC

businesses, environmental groups and the media. It provided pictures of the positive changes and barriers identified from these groups to further the climate change debates. More importantly, it gave a clear description of the interaction between business lobbyists and policy makers with regard to their willingness to act. The relationship between environmental NGOs and the media with regard to information sharing and public awareness was also described in the study (Carpenter 2001). Such discussions on these elements in the pre-UNFCCC period are lacking in the history of the study of climate change.

GLOBAL AND NATIONAL IMPLICATIONS

In this study, we first looked into the climate change discussion of the pre-UNFCCC period from the global viewpoint. It is observed that the science platform was the earliest and the leading platform and much attention was given to the science-policy interaction in the climate change discussion. From this study, we also notice that little mention is made of the relatively important science-media interaction as well as NGO participation in the climate change discussion. In this section, we discuss the implications of the climate change agenda at the global level and on a national level based on a descriptive case study of a developing country.

The discussion begins with a generic scenario of developing-country participation in the climate change discussion. It is followed by a discussion on the newly approved national policy on climate change by the Malaysian government. The purpose is to discuss the policies that are in place to address the needs and gaps identified from this study.

Although climate change is a global problem, this review of its historical development has highlighted the difference in views between developing countries and developed countries. One important factor is the intellectual development and advancement in climate change research.

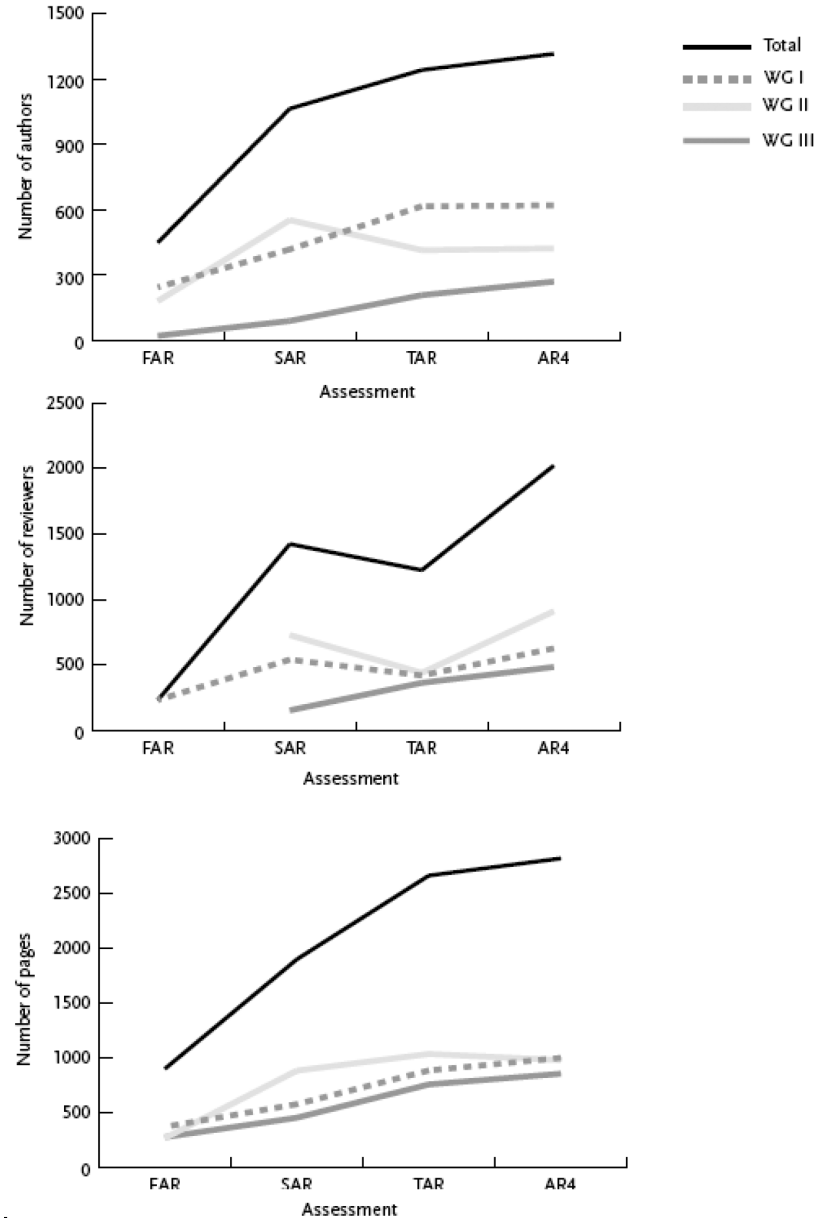
On the scientific platform, there have been seminal works produced by scientists from developed countries as early as the 15th century. These works are highly recognised and cited for their contribution in advancing climate change research and knowledge. The revolution that shaped the scientific communities of developed countries happened at the beginning of the industrial revolution which gave rise to interest in studying atmospheric carbon dioxide and surface temperature. World War II and the Cold War had even greater impacts on climate change research within the field of earth sciences following the new role of Western science societies and the relationship between governments and scientists (Doel 2003; Hart & Victor 1993; Lanchebery & Victor 1995). The other factor is the involvement and influence of the United States of America (USA) on the subject. This can be studied from research such as that conducted by Hart and Victor (1993) and Hecht and Tirpak (1995) which included an explicit review of the national climate change research development in the USA along with the historical timeline on a global platform. There does not appear to be such a review and assessment for developing countries as there is a lack of historical studies in this area.

Today our society still faces a similar challenge in increasing developing country participation on the scientific platform. This is observed from the IPCC which conducts scientific assessments with regard to climate change. It has been a challenge to the IPCC and several efforts have been undertaken to involve developing country scientists both as authors and reviewers (Agrawala 1998b). In 2010, an independent review of IPCC processes and procedures was conducted by the InterAcademy Council (IAC). Its review report records that among the current challenges facing the IPCC is that the scientific expertise for all three working groups reside predominantly in developed countries (InterAcademy Council 2010). According to the report, the lack of participation by developing-country scientists is attributed to several difficulties including a different language for communication, lack of support from home institutions, poor accessibility to literature and the small number of qualified scientists (InterAcademy Council 2010).

Within the same institution, the interaction between science and policy platforms is observed clearly. It consists of public policy-making on the national and international level on one side and scientific research and policy advice on the other (Siebenhüner 2003). The most direct interaction at the national level observed is that perhaps governments are becoming important players in providing a list of their home scientists for the co-chairs and vice chairs of each working group to decide on their coordinating lead authors and lead

authors (InterAcademy Council 2010; Siebenhüner 2003). However, the review report on the processes and procedures of the IPCC records disappointment with government focal points particularly among developing-country scientists for their home scientists' nomination process (InterAcademy Council 2010).

It is observed that there has been growing governmental participation in plenary sessions, an increase in the availability of publications for drafting an IPCC assessment and more engagement of authors and reviewers as well as increased lengths of assessment reports (Figure 5) from the IPCC and its scientific assessments (Agrawala 1998(b); InterAcademy Council 2010; Siebenhunner 2003). These elements drive IPCC as an increasingly important institution with the ability to provide different platforms for different purposes and players. At the same time, all these deliver an important message particularly to developing countries: The urgent need to enhance their indigenous capacity in climate change research and to promote effective communication and interaction among players.



Source: InterAcademy Council (2010)

FIGURE 5. Trends in the number of authors (top) and reviewers (middle) and in the length of the Working Group (WG) reports (bottom) from the first assessment (FAR) to second (SAR), third (TAR and fourth assessments (AR_4). Authors who participated in two Working Groups for any given assessment are counted twice for that assessment. Reviewer names were not listed in the Working Group II or III reports for the first assessment

MALAYSIA AND ITS NATIONAL POLICY ON CLIMATE CHANGE

The formulation of the National Policy on Climate Change (NPCC) is an important milestone for Malaysia in its efforts at addressing the challenges of climate change. The Ministry of Natural Resources and Environment, Malaysia decided on its formulation in 2007. It was the outcome of a study entitled 'Policy Study on Climate Change' under the Ninth Malaysia Plan. The main purpose of the study was to develop a national policy and strategies to address the issues of climate change at the national and international level (LESTARI 2009).

The NPCC was approved by the Malaysian Cabinet in 2009 and the document was published the following year. Its delineates five principles to strengthen its ten strategic thrusts that direct national responses on climate change in all sectors (Ministry of Natural Resources and Environment, Malaysia 2010). A total of 43 key actions have been developed for its implementation. An overview of the structure of the NPCC is presented in Figure 6.

In this section, key actions which will assist the country in enhancing scientific research and development, improving science-policy interaction, addressing the lack of science-media interaction and NGO participation in climate change discussion are the main focus. These are the needs and gaps identified from this study. A short list consisting of 7 key actions is presented in Table 3. These key actions share a similarity in their efforts to formalise and institutionalise certain mechanisms for research and development, communication and interaction and participation.

The review shows that science is the most important element and the leading platform for climate change discussions but at the same time it is a challenge for the developing countries. Intentions to establish a national research and development agenda on climate change are evident from the NPCC. Institutionalisation of the climate change research agenda is a benefit to the scientific society as it secures funding, consolidates the diversity of research and sustains the continuity of climate change research. It is also observed that the research areas have been identified and can yield great advantages in enhancing the country's adaptation capacity level and in providing localised climate change impact assessments. The identifying of research and development avenues as a priority to a developing country is necessary because it has limited resources to address the diversity of climate change issues. Thus, priority should be given to sectors that are affected the most by the impacts of climate change. In addition to drawing up a research and development agenda, a pool of climate change experts is recommended and this is also required to foster greater participation of developing-country scientists. At the same time, it provides a better organised and exhaustive list of experts and their fields of expertise to the government. This move will also assist a more transparent and robust home scientists' nomination process for submission to the IPCC for scientific assessments.

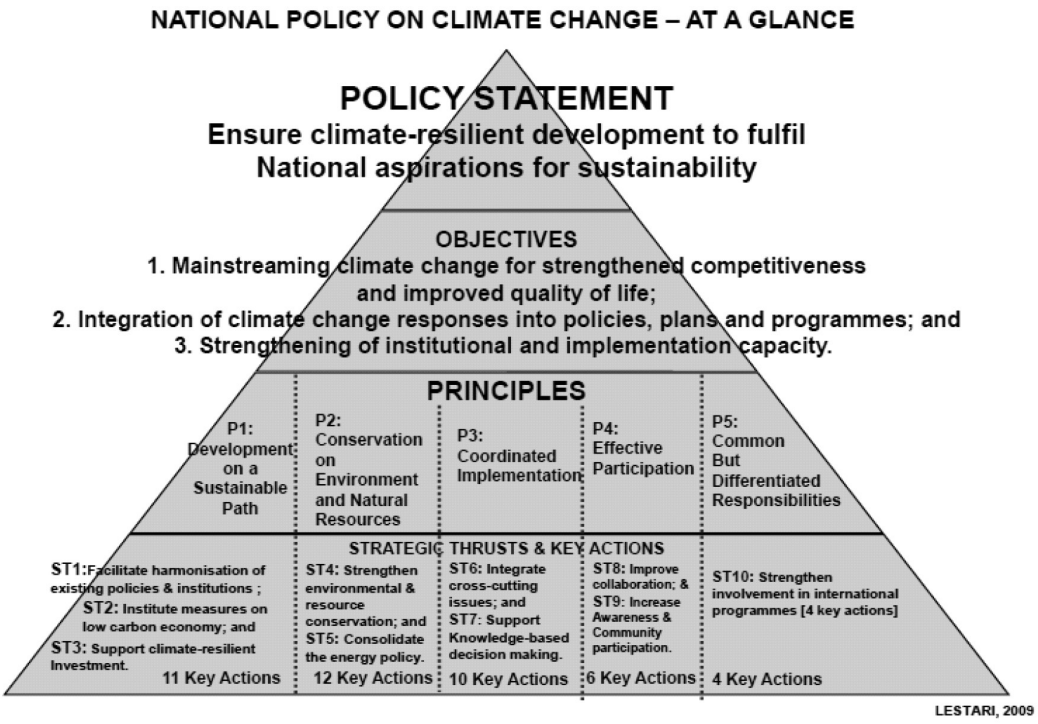


FIGURE 6. An overview of the National Policy on Climate Change Malaysia (Lestari 2009)

TABLE 3. Key actions of the NPCC that address the need and gaps identified from climate change discussion platforms

The identified needs and gaps to address	Key actions of the NPCC identified
Enhancing scientific research and development	Establish and implement a national R&D agenda on climate change taking into account the following areas: agriculture and food security; water security and services; forestry and ecosystem services; sustainable bio-energies; public health services and delivery; localised modelling for projection of future scenarios; innovative socio-economic and financing mechanisms; vulnerability due to extreme weather events and natural disasters; and policy analysis harmonising national and international issues (KA28-ST7) Establish a register and expand the pool of climate change experts (KA40-ST7)
Improving science-policy interaction	Identify a coordinating mechanism to oversee R&D activities, information dissemination, avoidance of duplication, and to support decision making (KA32-ST7) Institutionalise measures to strengthen effective linking of climate science and policy (KA33-ST7) Establish and institutionalise effective and efficient communication and consultation mechanisms among all stakeholders (KA34-ST8)
Lacking of science-media interaction	Identify a coordinating mechanism to oversee R&D activities, information dissemination, avoidance of duplication, and to support decision making (KA32-ST7) Establish and institutionalise effective and efficient communication and consultation mechanisms among all stakeholders (KA34-ST8)
Lacking of NGOs participation	Develop and implement plans for public-private, NGOs, and communities collaboration on climate change (KA14-ST4) Identify a coordinating mechanism to oversee R&D activities, information dissemination, avoidance of duplication, and to support decision making (KA32-ST7) Establish and institutionalise effective and efficient communication and consultation mechanisms among all stakeholders (KA34-ST8) Promote community-based climate change responses and programmes (KA36-ST8)

**Note: Key actions are taken from the National Policy on Climate Change with their reference number indicated
Source: Compiled from information in the National Policy on Climate Change

An influential interaction observed from this study is the science-policy interaction. With regard to this, it is noticed that three key actions can potentially assist Malaysia to manage this aspect. These key actions are developed for two strategies which highlight the importance of knowledge-based decision making and the necessity for efficient stakeholders' communication and coordination (Ministry of Natural Resources and Environment, Malaysia 2010). The most straightforward step is to institutionalise and strengthen the science and policy linkages effectively. In this matter, it is necessary to identify the availability of existing mechanisms or measures to prompt this key action. It is also observed that two key actions out of these three to improve the science-policy interaction are also applicable to address the lack of science-media interaction and NGO participation. Actions include dissemination of information and improving stakeholders' communication and consultation (Ministry of Natural Resources and Environment, Malaysia 2010).

Taken together, these two key actions which suggest the establishment of research and development coordinating mechanisms and stakeholders' communication and consultation will result in a greater impact. These mechanisms can facilitate the science-media-policy interaction with participation from NGOs. It is envisioned as a source for information dissemination derived from activities of research and development. Sciences reach the public in the form of education and awareness through the media and NGOs. Meanwhile policy decisions and activities with regard to climate change are made based on the sciences. Both the media and NGOs can play a role in monitoring and overseeing these interactions. Thus, an inclusive stakeholders' involvement in these proposed mechanisms is a precondition to their establishment.

CONCLUSION

Science, media and policy are three important platforms of climate change. Science is essential for generating knowledge on climate change. The media plays a critical role in communicating this knowledge to the public. The policy platform draws on both science and media to make interventions to address the issue.

The three platforms identified from this study are undoubtedly important drivers to the climate change discussion. Nevertheless, it is observed that discourse on

climate change would not have reached such a peak if not for the discussion, attention and actions within all of these platforms. At the same time, it is found that the review of the interactions with non-governmental organisations on this subject is insufficient.

Interaction is an essential element and it has occurred among these three platforms. It is critical in order to attract greater attention to the climate change discourse. Thus, to ensure effective interaction between platforms, it is suggested that NGOs should play a more important role in this matter. It is also suggested that interaction between the science and media platform be strengthened.

The descriptive case study suggests that, in Malaysia, the climate change discussion is more likely to be driven by policy. The NPCC plays an important role to assist the country in enhancing scientific research and development, improving science-policy interaction, addressing the lack of science-media interaction and NGO participation in the climate change discussion.

ACKNOWLEDGEMENTS

The authors would like to thank Associate Prof. Dr. Rawshan Ara Begum for reading and commenting on an earlier version of this paper. This paper is partly funded by a study entitled 'Policy Study on Climate Change' under the Ninth Malaysia Plan. The study was conducted jointly by the Environmental Management and Climate Change Division of the Ministry of Natural Resources and Environment Malaysia and Institute for Environment and Development (LESTARI). This paper has also benefited from the funding provided by OUP 2012 (OUP-2012-113) and COE-LESTARI (XX-07-2012).

REFERENCES

Agrawala, S. 1998a. Context and early origins of the intergovernmental panel on climate change. *Climatic Change* 39: 605-620.

Agrawala, S. 1998b. Structural and process history of the intergovernmental panel on climate change. *Climatic Change* 39: 621-642.

Agrawala, S. 1999. Early science-policy interactions in climate change: Lessons from the advisory group on greenhouse gases. *Global Environmental Change* 9: 157-169.

Andresen, S. & Agrawala, S. 2002. Leaders, pushers and laggards in the making of the climate regime. *Global Environmental Change* 12: 41-51.

Arrhenius, S. 1908. *Worlds in the Making: The Evolution of the Universe*. Translated by Borns, H. New York: Harper and Brothers.

Bodansky, D.M. 1993. The United Nations framework convention on climate change: A commentary. *Yale Journal of Law* 18: 451-558.

Bostrom, A., Morgan, M.G., Fischhoff, B. & Read, D. 1994. What do people know about global climate change? 1. Mental Models. *Risk Analysis* 14: 959-970.

Boykoff, M.T. 2008. Media and scientific communications: A case of climate change. *Geological Society, London, Special Publications* 305: 11-18.

Boykoff, M.T. & Roberts, J.T. 2007. Media coverage of climate change: Current trends, strengths, weaknesses. Occasional Paper, UNDP Human Development Report 2007/2008.

Callendar, G.S. 1938. The artificial production of carbon dioxide and its influence on temperature. *Quarterly Journal of Royal Meteorological Society* 64: 223-240.

Carpenter, C. 2001. Business, green groups and the media: The role of non-governmental organizations in the climate change debate. *International Affairs* 77: 313-328.

Corfee-Morlot, J., Maslin. M. & Burgess, J. 2007. Global warming in the public sphere. *Philosophical Transactions of the Royal Society A* 365: 2741-2776.

Doel, R.E. 2003. Constituting the postwar earth sciences: The military's influence on the environmental sciences in the USA after 1945. *Social Studies of Science* 33: 635-666.

Fleming, J.R. 1998. *Historical Perspectives of Climate Change*. New York: Oxford University Press.

Fourier, Jean-Baptiste J. 1824. General remarks on the temperature of the earth and outer space. Translated by Ebenezer Burgess. *America Journal of Science* 32: 1-20.

Handel, M.D. & Risbey, J.S. 1992. An annotated bibliography on the greenhouse effect and climate change. *Climatic Change* 21: 97-255.

Hart, D.M. & Victor, D.G. 1993. Scientific elites and the making of US policy for climate change research, 1957-1974. *Social Studies of Science* 23(4): 643-680.

Hecht, A.D. & Tirpak, D. 1995. Framework agreement on climate change – a scientific and policy history. *Climatic Change* 29(4): 371-402.

Institute for Environment and Development (LESTARI). 2009. Ninth Malaysia Plan (RMK9): Policy Study on Climate Change Final Report to Ministry of Natural Resources and Environment Malaysia.

InterAcademy Council. 2010. Climate Change Assessments, Review of the Processes and Procedures of the IPCC. Amsterdam: Committee to Review the Intergovernmental Panel on Climate Change.

Kalnicky, R.A. 1974. Climatic change since 1950. *Annals of the Association of American Geographers* 64(1): 100-112.

Kellogg, W.W. 1987. Mankind's impact on climate: The evolution of an awareness. *Climatic Change* 10: 113-136.

Lanchbery, J. & Victor, D. 1995. The Role of Science in the Global Climate Negotiations'. In *Green Globe Yearbook of International Co-operation on Environment and Development 1995*, edited by Helge Ole Bergesen, Georg Parmann, Oystein B. Thommessen. Oxford: Oxford University Press.

Le Treut, H., Somerville, R., Cubasch, U., Ding, Y., Mauritzen, C., Mokssit, A., Peterson, T. & Prather, M. 2007: Historical overview of climate change. In *Climate change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* edited by Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. & Miller, H.L. Cambridge, United Kingdom and New York, USA: Cambridge University Press. pp. 93-128.

Ministry of Natural Resources and Environment Malaysia. 2010. *Dasar Perubahan Iklim Negara (National Policy on Climate Change)*.

Paterson, M. & Grubb, M. 1992. The international politics of climate change. *International Affairs* 68: 293-310.

Revelle, R. & Suess, H.E. 1957. Carbon dioxide exchange between atmosphere and ocean and the question of an increase of atmospheric CO_2 during the past decades. *Tellus* 9(1): 18-27.

Seki, M. & Christ, R. 1995. Selected international efforts to address climate change. *Environmental Monitoring and Assessment* 38: 141-153.

Sewell, G.C. 1996. Conflicting beliefs: National implementation of the United Nations Framework Convention on Climate Change. *Environmental Impact Assessment Review* 16: 137-150.

Seyfang, G. 2003. Environmental mega-conferences – from Stockholm to Johannesburg and beyond. *Global Environmental Change* 13: 223-228.

Siebenhüner, B. 2003. The changing role of nation states in international environmental assessments – the case of the IPCC. *Global Environmental Change* 13: 113-123.

Solomon, S., Qin, D., Manning, M., Alley, R.B., Berntsen, T., Bindoff, N.L., Chen, Z., Chidthaisong, A., Gregory, J.M., Hegerl, G.C., Heimann, M., Hewitson, B., Hoskins, B.J., Joos, F., Jouzel, J., Kattsov, V., Lohmann, U., Matsuno, T., Molina, M., Nicholls, N., Overpeck, J., Raga, G., Ramaswamy, V., Ren, J., Rusticcucci, M., Somerville, R., Stocker, T.F., Whetton, P., Wood, R.A. & Wratt, D. 2007. Technical Summary. In *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* edited by Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. & Miller, H.L. Cambridge, United Kingdom and New York, USA: Cambridge University Press. pp. 19-91.

Stanhill, G. 2001. The growth of climate change science: A scientometric study. *Climatic Change* 48: 515-524.

Starr, P. 2004. *The Creation of the Media: Political Origins of Modern Communications*. New York: Basic Books.

Tyndall, J. 1861. On the absorption and radiation of heat by gases and vapours, and on the physical connection of radiation, absorption, and conduction. *Philosophical Magazine and Journal of Science* 22(4): 169-285.

United Nations. 1988. *Protection of Global Climate for Present and Future Generations*. General Assembly Resolution 53, 43. UN Document A/43/49. New York: United Nations.

United Nations. 1989. *Protection of Global Climate for Present and Future Generations*. General Assembly Resolution 207, 44. UN Document A/44/862. New York: United Nations.

United Nations. 1990. *Protection of Global Climate for Present and Future Generations*. General Assembly Resolution 212, 45. UN G.A.O.R. Supplement. (49) 147–149, UN Document A/45/49. New York: United Nations.

Ungar, S. 1992. The rise and (relative) decline of global warming as a social problem. *The Sociological Quarterly* 33(4): 483-501.

Weart, S.P. 2004. *The Discovery of Global Warming*. Massachusetts: Harvard University Press.

Wilson, K.M. 2000. Drought, debate, and uncertainty: Measuring reporters' knowledge and ignorance about climate change. *Public Understanding of Science* 9: 1-13.

WMO. 1979. *Proceedings of the World Climate Conference – a conference of experts on climate and mankind, 12-13 February 1979*. WMO Publication No. 537. Geneva: World Meteorological Organization.

WMO. 1985. *Report of the international conference on the assessment of the role of carbon dioxide and of other greenhouse gases in climate variations and associated impacts, 9-15 October 1985*. WMO Publication No. 661. Geneva: World Meteorological Organization.

Zehr, S.C. 2000. Public representations of scientific uncertainty about global climate change. *Public Understanding* 9: 85-103.

Koh Fui Pin & Joy Jacqueline Pereira*
Southeast Asia Disaster Prevention Research Institute (SEADPRI)
Universiti Kebangsaan Malaysia
43200 Bangi
Malaysia

Sarah Aziz
Institute for Environment and Development (LESTARI)
Universiti Kebangsaan Malaysia
43200 Bangi
Malaysia

*Corresponding author; email: joy@ukm.my

Received: 1 November 2011
Accepted: 3 April 2013